(19) Eur päi h Pat ntamt
European Patent Office
Offi uropéen des br v ts

(11) EP 0 959 245 A2

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**24.11.1999 Bulletin 1999/47**

(51) Int Cl.[6]: **F02M 55/02**, F02M 63/00

(21) Application number: **99303884.3**

(22) Date of filing: **19.05.1999**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE**
Designated Extension States:
**AL LT LV MK RO SI**

(30) Priority: **20.05.1998 FI 981126**

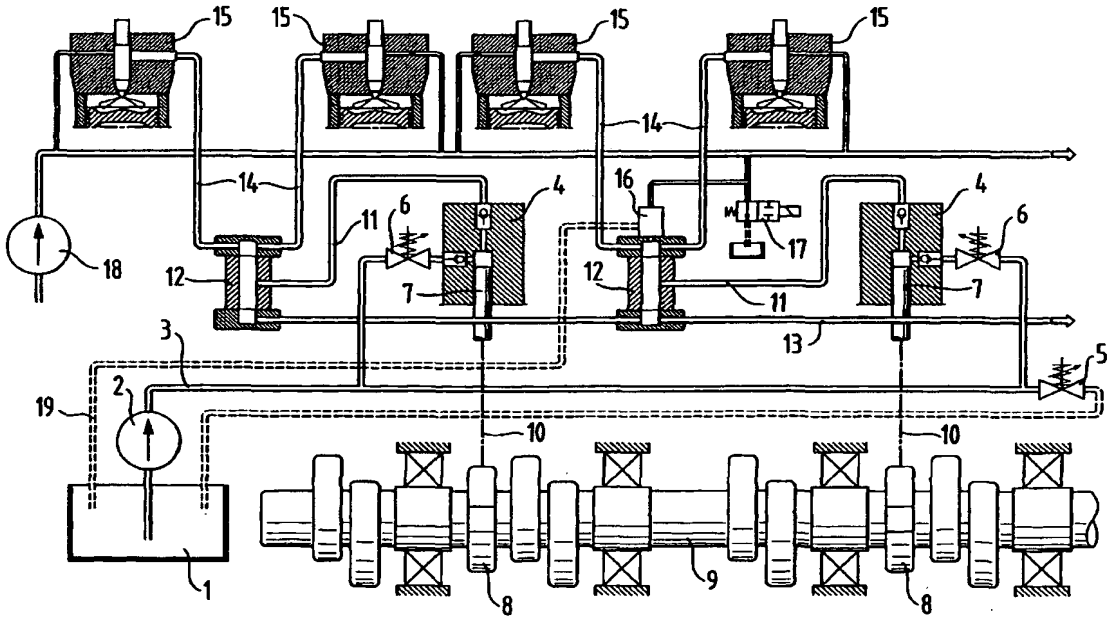
(71) Applicant: **Wärtsilä NSD OY AB**
**00530 Helsinki (FI)**

(72) Inventor: **Jay, David C.**
**66500 Vähäkyrö (FI)**

(74) Representative: **Newby, Martin John et al**
**JY & GW Johnson,**
**Kingsbourne House,**
**229-231 High Holborn**
**London WC1V 7DP (GB)**

## (54) Fuel feeding system

(57) A fuel feeding system for an engine with several cylinders, especially a large diesel engine, in which the fuel is fed from a fuel tank (1) by means of high pressure pumps (4) into a pressure supply, from which it is fed further by means of injectors (15) into the cylinders of the engine, whereby the pressure supply of fuel includes at least two separate pressure accumulator units (12), each of which is connected to at least two injectors (15) and which are provided with a high pressure pump (4) of their own. The pressure spaces of the pressure accumulator units (12) are continuously in connection with each other. In addition one of the pressure accumulator units (12) of the system is provided with a valve (16), by means of which the pressure space of the pressure accumulator unit (12) in question and at the same time the pressure spaces connected thereto can be connected to the fuel tank (1).




EP 0 959 245 A2

## Description

**[0001]** This invention relates to a fuel feeding system for an engine with several cylinders, especially a large diesel engine, in which the fuel is fed from a fuel tank into a pressure supply by means of a high pressure pump and from the pressure supply into the cylinders of the engine by means of injectors in accordance with the preamble of claim 1.

**[0002]** In this specification the term "large diesel engine" refers to such engines that are used, for example, as main propulsion engines or auxiliary engines in ships or in power plants for the production of heat and/or electricity.

**[0003]** In modern engines fuel is injected by means of a fuel injecting valve or an injector directly into the cylinders of an engine. Since the injection occurs at a relatively late phase at the end part of the compression stroke, a sufficiently high pressure is required for the injection. In a conventional fuel feeding system, each cylinder is provided with an injection pump of its own which pumps fuel through an injection valve and an injection nozzle into the combustion chamber of the cylinder. However, this arrangement is expensive since it requires many separate components. In addition the pressure in the injection pumps may vary, so that the injection into the different cylinders may take place under different pressures and may thus provide different amounts of fuel, respectively.

**[0004]** A more recent solution is the so called "common rail injection" or "common pressure injection", in which the provision of pressure and the injection of fuel are functionally separated from each other. Fuel is fed by means of a high pressure pump into a common pressure supply, from which it is led through separate pipes into the injector of each cylinder. In practice the operation of an injector is electronically controlled, for instance by means of a magnet valve, in order to obtain a sufficiently short and precise injection.

**[0005]** The use of the common rail system, especially in large engines, has certain drawbacks because of the length of the uniform fuel rail serving as the pressure supply. Depending on the type of engine, the length of such a fuel rail may be in excess of 3 m. If the uniform fuel rail is long and narrow, severe pressure waves or pressure pulses moving back and forth are easily created in it and these affect correspondingly the amount of fuel injected into separate cylinders. In addition due to the high pressures used the strength of a long and uniform fuel rail and thus the security of the system may become a problem. On the other hand if a uniform fuel rail is long and has a relatively large diameter so as to prevent the occurrence of such pressure waves and the fuel in it becomes cool, reheating of the fuel to its operating temperature takes a respectively longer time. This may be a problem especially when heavy fuel oils are utilized.

**[0006]** The aim of the present invention is to provide a new improved fuel feeding system which is especially applicable to large diesel engines and from which the problems apparent in the known solutions mentioned above are eliminated. The aim of the invention is to provide a fuel feeding system which enables a fuel pressure more constant than before to be maintained and which is as a whole more secure and reliable than before and yet advantageous as to its costs.

**[0007]** The aims of the invention can be achieved in a way shown in claim 1 and in the other claims. In accordance with the invention the pressure spaces of the pressure accumulator units are continuously in connection with each other. In addition one of the pressure accumulator units of the system is provided with a valve, by means of which the pressure space of the pressure accumulator unit in question and at the same time the pressure spaces connected thereto can be connected to the fuel tank. This enables, for instance, the fuel to be circulated for heating thereof before the engine is started, which is of importance especially when heavy fuel oil is utilized. By using a fuel supply system according to the invention it is possible to avoid the use of a long uniform fuel rail and, yet, the system makes it possible effectively to balance the possible pressure differences between the separate pressure accumulator units. The strength of the construction is no problem either in this case so the system is more reliable and more secure than before.

**[0008]** The system includes with advantage a low pressure pump for feeding fuel from the fuel tank through the high pressure pumps into the pressure accumulator units. In this case a feed circuit of the low pressure pump is provided with throttle means, a constant pressure valve or the like for maintaining a uniform feeding pressure. In practice the pressure in the feeding circuit of the low pressure pump may with advantage be from 5 to 10 bar. Hereby the part of the fuel feeding system under high pressure can essentially be limited, which improves the reliability of the system and decreases costs, since the components for this part may be simpler.

**[0009]** Each high pressure pump is with advantage provided with a control valve, by means of which the volume flow provided by the high pressure pump is defined and by means of which the connection between the high pressure pump and the low pressure pump can additionally be closed. In addition, by opening and closing the control valves, it is possible to ensure that fuel flow takes place through all the pressure accumulator units.

**[0010]** The valve in the pressure accumulator unit may with advantage serve also as a constant pressure valve and it may be utilized in order to de-pressurize the pressure accumulator units when necessary.

**[0011]** The fuel pressure in the pressure accumulator unit is suitably from about 800 to 1600 bar, preferably from 1000 to 1400 bar. When the pressure accumulator unit is connected to at least two injectors the volume of its pressure space can with advantage be defined on

the basis of the formula:

$$S = V_{tot}/(V_{inj} \cdot N_{cyl}),$$

in which

$V_{tot}$ = the common volume of all the pressure accumulator units (12);

$V_{inj}$ = the amount (volume) of fuel injected by one injector for one combustion occurrence of a cylinder, under full (100%) engine load; and

$N_{cyl}$ = the number of cylinders in the engine;

so that the value of S is in the range of from 50 to 100.

**[0012]** The pressure accumulator units are connected to each other by means of a pipe or a duct connected from one unit to another and having a diameter typically from 4.5 to 5.0 mm, preferably about 4.7 mm. These dimensions can affect the extent of vibrations and pressure waves which might occur in the system and they are dependent on the construction of the system in each case. The diameter of the connecting pipe is in practice a compromise whereby different features and properties such as dampening of pressure waves and the need to circulate fuel before starting the engine should be taken account of.

**[0013]** The high pressure pump receives its guidance from one or more cams of a cam shaft of the engine.

**[0014]** Embodiments of the invention will now be described, by way of example only, with particular reference to the accompanying drawing, the sole figure of which shows schematically an embodiment of a fuel feeding system according to the invention.

**[0015]** In the drawing reference numeral 1 indicates a fuel tank from which fuel is pumped by means of a low pressure pump 2 along a fuel line 3 into high pressure pumps 4. The fuel line 3 is under relatively low constant pressure, for instance about 7 bar. The fuel line is provided with a constant pressure valve 5, through which the line 3 can be reconnected to the fuel tank 1. Instead of the constant pressure valve 5, a simpler throttle member may be used to maintain the low constant pressure.

**[0016]** The high pressure pumps 4 are provided with control valves 6 and piston members 7. The piston members receive their guidance 10 from cam members 8 of a cam shaft 9 of the engine. When necessary, each cam member 8 may include several cams, whereby when a high pressure pump provides a certain volume flow per unit time into a pressure accumulator unit the outer dimensions of the pump may respectively be kept smaller so that the pressure shocks provided by it are correspondingly smaller.

**[0017]** Each high pressure pump 4 is connected by means of a high pressure line 11 to a separate pressure accumulator unit 12. Each accumulator unit 12 is connected by means of pipes or ducts 14 to electronically controlled injectors 15 installed for two cylinders of the engine.

**[0018]** The pressure accumulator units 12 are connected to each other by means of a pipe 13. The purpose of the pipe 13 is to decrease possible pressure differences between the accumulator units. In practice the pressure prevailing in the high pressure line 11 and in the pressure accumulator units 12 is about 1200 bar but, if required, it may be varied preferably within the range of from 1000 to 1400 bar. Temporarily the pressure may even rise up to at least 1600 bar. When desired the operation of the high pressure pumps 4 and the injection pressures to be used can be controlled in accordance with engine load, operating speed or other parameters in a way known per se.

**[0019]** One pressure accumulator unit 12 in the system is provided with an auxiliary valve 16, the operation of which is controlled by a precontrol valve 17 attached to a servo oil circuit of the engine. A servo oil pump 18 maintains a pressure of about 100 bar and the servo oil circuit is also made use of in a way known as such for the injectors 15 to control the injection of fuel together with a conventional solenoid valve (not shown). By means of the valve 16 the pressure accumulator units 12 of the system may be connected through a line 19 to the fuel tank 1. Thus, when necessary, by means of the valve 16 the pressure accumulator units 12 may be depressurized. In addition the valve 16 makes it possible to circulate fuel for instance for the purpose of heating it before starting of the engine. When desired, by opening and closing the control valves 6 in turn, it is also possible to ensure by means of the valve 16 that the fuel flow takes place through all the pressure accumulator units 12. Further the valve 16 may with advantage serve as a constant pressure valve since, in any event, the high pressure circuit also needs a constant pressure valve.

**[0020]** In the embodiment shown the volume of the pressure space of the pressure accumulator units 12 may with advantage be about 0.7 litre and the diameter of the pipe 13 connecting the accumulator units 12 together may be about 4.7 mm. These dimensions are most suitable for the case in which the injection into each cylinder is about 4700 $mm^3$ at full effect and full load of the engine, and they are prone for their part to eliminate possible pressure pulses between the accumulator units.

**[0021]** For clarity, the figure shows only two pressure accumulator units 12 which feed fuel to injectors installed to four cylinders of the engine. The system according to the invention may naturally be applied to engines with several cylinders independent on the number of cylinders in each case. Similarly, when desired, on pressure accumulator unit may also feed fuel for, for example, three cylinders.

**[0022]** This should naturally be taken account of when dimensioning the system.

**[0023]** The invention is not restricted to the embodiment shown, but several modifications are feasible within the scope of the attached claims.

## Claims

1. A fuel feeding system for an engine with several cylinders, especially a large diesel engine, in which the fuel is fed from a fuel tank (1) to pressure supply means by means of high pressure pump means (4) and from the pressure supply means to the cylinders of the engine by means of injectors (15), whereby the pressure supply means includes at least two separate pressure accumulator units (12), each of which is connected to at least two injectors (15) and which is provided with a separate high pressure pump (4) of said high pressure pump means, characterized in that the pressure accumulator units (12) have pressure spaces continuously in connection with each other and in that one of the pressure accumulator units (12) is provided with a valve (16) for connecting the pressure spaces of the pressure accumulator units to the fuel tank (1).

2. A fuel feeding system according to claim 1, characterized in that it includes a low pressure pump (2) for feeding fuel from the fuel tank (1), through the high pressure pumps (4) and into the pressure accumulator units (12).

3. A fuel feeding system according to claim 2, characterized in that a feed circuit (3) of the low pressure pump (2) is provided with throttle means, a constant pressure valve or the like (5) for maintaining a uniform feeding pressure.

4. A fuel feeding system according to claim 2 or 3, characterized in that the pressure in the feeding circuit (3) of the low pressure pump (2) is from 5 to 10 bar.

5. A fuel feeding system according to any one of the preceding claims, characterized in that each high pressure pump (4) is provided with a control valve (6), by means of which the volume flow provided by the high pressure pump (4) is defined and by means of which the connection between the high pressure pump (4) and the low pressure pump (2) can additionally be closed.

6. A fuel feeding system according to any one of the preceding claims, characterized in that said valve (16) of said one pressure accumulator unit (12) also serves as a constant pressure valve.

7. A fuel feeding system according to any one of the preceding claims, characterized in that the fuel pressure in the pressure accumulator unit (12) is from about 800 to 1600 bar, preferably from 1000 to 1400 bar.

8. A fuel feeding system according to any one of the preceding claims, characterized in that when each pressure accumulator unit (12) is connected to at least two injectors the volume of its pressure space is defined on the basis of the formula:

$$S = V_{tot} / (V_{inj} \cdot N_{cyl}),$$

in which

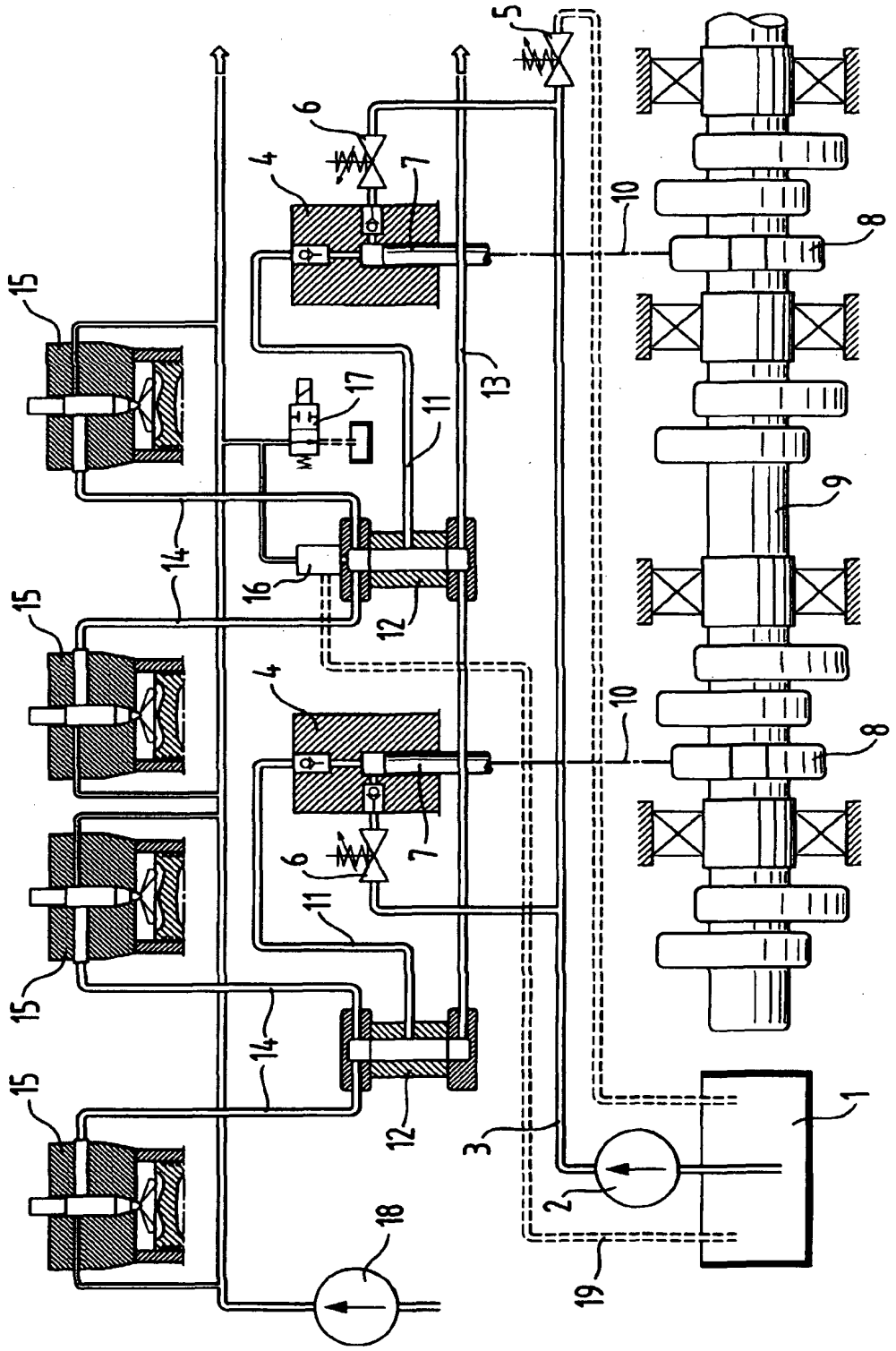
$V_{tot}$ = the common volume of all the pressure accumulator units (12);
$V_{inj}$ = the amount (volume) of fuel injected by one injector for one combustion occurrence of a cylinder, under full (100%) engine load; and
$N_{cyl}$ = the number of cylinders in the engine;

so that the value of S is in the range of from 50 to 100.

9. A fuel feeding system according to any one of the preceding claims, characterized in that the pressure accumulator units (12) are connected to each other by means of a pipe (13) or a duct connected from one unit to another and the diameter of which is from 4.5 to 5.0 mm, preferably about 4.7 mm.

10. A fuel feeding system according to any one of the preceding claims, characterized in that the high pressure pump (4) receives its guidance from one or more cams (8) of a cam shaft (9) of the engine.

11. An engine comprising several cylinders and having a fuel feeding system as claimed in any one of the preceding claims.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19